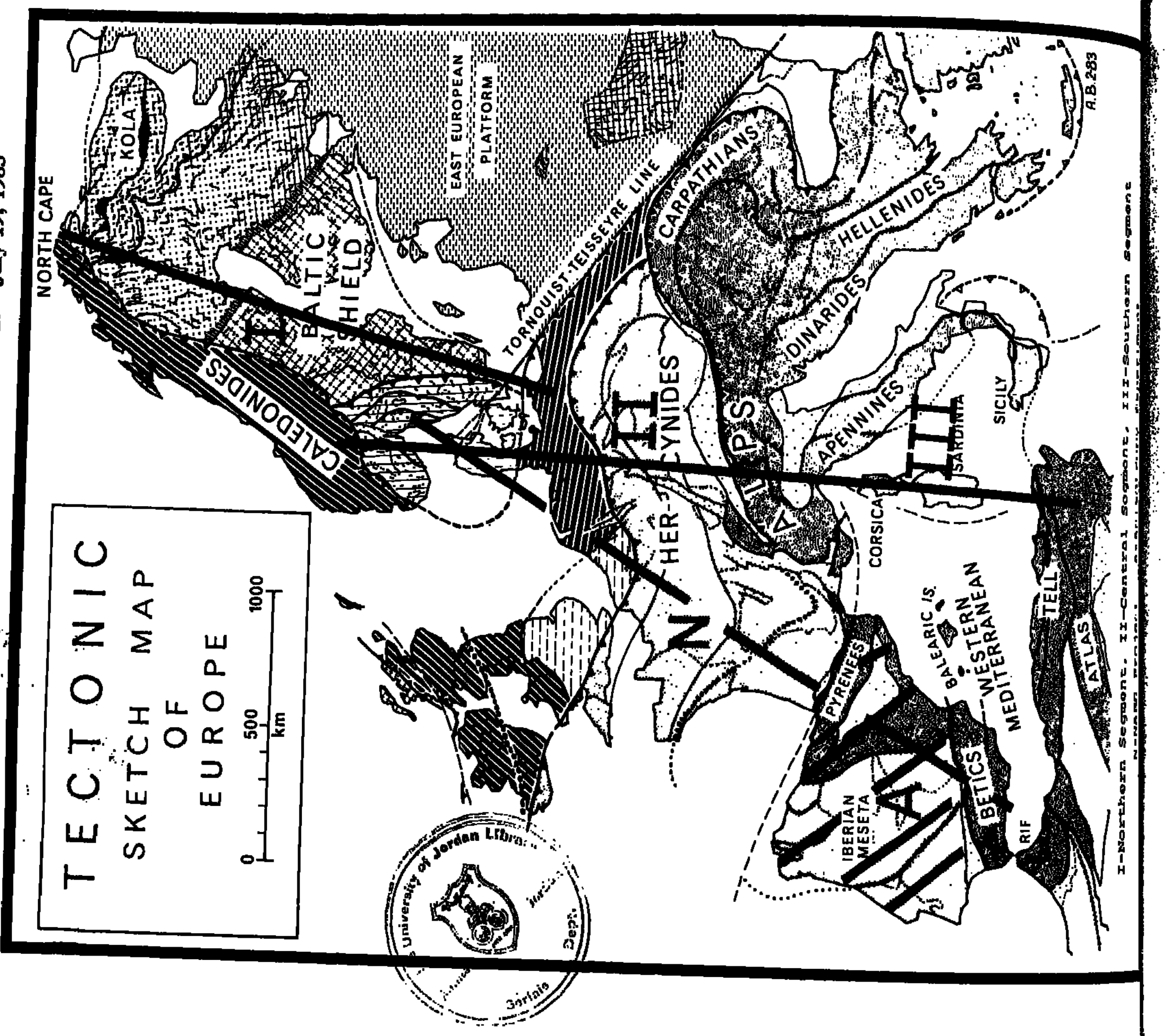

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IUGG Quadrennial Report Overviews

Chemical Oceanography 1979–1982

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The last four years have brought exciting advances in oceanography within the United States. The traditional research approach of a modest program built around a single investigator was supplemented during the International Decade of Ocean Exploration in the United States by a series of large-scale cooperative programs involving many investigators, often from a multitude of institutions. Continuing with this approach has allowed us to attack otherwise intractable problems. The broad range in program scales, from small to rather large, utilizes both individual creativity and the synergism of many obeservations focused on a single process; it continues to produce rich returns.

Among the large programs with substantial impact on chemistry or paleooceanography were: Transient Tracers in the Ocean (TTO), Sea/Air Exchange (SEAREX), Manganese Nodule Program (MANOP), Coastal Upwelling Ecosystems Analysis (CUEA), Particle Flux Intercalibration (PARFLUX), Subseabed Disposal, Warm Core Rings, Spectral Mapping (SPECMAP), and Cenozoic Paleooceanography (CENOP).

Meanwhile, results continue to pour in from earlier programs that have been completed. The Deep Sea Drilling Project continues to contribute to our understanding of seafloor processes and of paleooceanography. As this report period ended, the fate of scientific ocean drilling was shrouded in uncertainty, but the program has been very successful and will surely continue in some format.

Optimism over the general progress of marine science has been mixed with pessimism over a series of development in U.S. support for marine research. The sharp rise in operating costs has produced a significant reduction in the U.S. ocean research fleet. Ship time has become less available. Political changes have led to curtailment of many federally sponsored research activities. Although the National Science Foundation (NSF) has fared relatively well during this period, substantial cutbacks at the Environmental Protection Agency, at the National Oceanic and Atmospheric Administration, and others have shifted much more responsibility for supporting oceanographic research onto NSF and the Office of Naval Research. For these and other reasons the number of students entering the field declined during this period.

A few of the trends and developments identified in the accompanying reviews might be highlighted here. First, we have seen a shift away from the one-dimensional, vertical diffusion-advection models that dominated our thinking a few years ago. Physical oceanographers have been lecturing chemists on the relative importance of horizontal processes and the difficulty of vertical mixing in stratified waters; no longer can we neglect horizontal mixing (the product of very small gradients and very large mixing coefficients) in comparison to vertical mixing (the product coefficients). Accounting for three-dimensional distributions is obviously much more complicated, but the growing body of oceanographic data begins to make this possible. Future work will involve increased emphasis on horizontal mixing tracers and rate evaluations.

Organic marine chemistry has blossomed in the last few years. Here the role played by Neil Andersen should be noted. By organizing symposia, by editing books, and by unrelenting enthusiasm for this subdiscipline, he has had a major effect. Not long ago, marine organic chemists could identify just one-tenth of the organic material from the sea. Today that fraction is much larger and may exceed one-half. These advances were promoted by increased use of new analytical method and instruments such as the gas chromatograph-mass spectrometer, and by improved sampling techniques. As a result, organic marine chemistry has shifted emphasis from chemical analysis to the study of processes—where understanding the production, consumption, and transport mechanisms are part of the research goal. Progress in this area is accelerating. The first appearance of Marine Organic Geochemistry as a separate chapter in this report represents a recognition of this progress.

Marine pollution has remained a matter of serious concern, but the focus of attention has shifted somewhat. The international Group of Experts on Scientific Aspects of Marine Pollution (GESAMP) reviewed the "Health of the Oceans" and found much greater cause for concern at the ocean edges, in bays, and estuaries than in the open sea.

The problem of fossil fuel CO_2 continues to attract considerable attention, but students of the problem seem somewhat less alarmed than they were four years ago. High prices for fossil fuels have slowed the rate of CO_2 release—perhaps buying more time to deal with this problem.

The possibility that CO_2 might change our climate has helped stimulate interest in past climates. The continuing flow of results from the Climate: Long-Range Investigation, Mapping, and Prediction (CLIMAP) program has combined with current large programs and an increasing array of individual investigators to produce striking growth in the field of paleooceanography. Research efforts have been aided by wider use among paleontologists of isotope ratio studies—principally oxygen, but with increased attention given to carbon isotopes, also.

Studies of benthic foraminifers have greatly increased our knowledge of paleocirculation patterns in the deep oceans. Changing ocean shapes affect both biological activity and the circulation patterns and thus influence distribution patterns of chemicals in the seas. As our understanding of these effects evolves, we may see growing together of the fields of marine chemistry and paleoceanography.

Enrichment of iridium in sediments deposited at the upper boundary of the Cretaceous has stimulated a great deal of discussion, controversy, and research concerning extinctions at the end of the Mesozoic era. Was this event indeed the result of a meteorite impact? How important have meteorite impacts been in the history of the earth's biosphere?

Observations from satellites are playing an increasing role in oceanography, although of less importance for chemists than for physical oceanographers. The growing interest in fronts and mesoscale eddies derives support from satellite observations, and many mesoscale studies are possible only because of the overview. Another significant development is the growing use of continuous underway measurements made from ships. Development of this capability has benefited substantially from the support of Edward Green at the Office of Naval Research.

Photochemistry represents another area of rapidly growing interest, both for atmospheric and marine chemists. The flux of photons entering the sea causes many more reactions than just photosynthesis. The resulting products are, for the most part, highly reactive and often very exotic chemical species. The implications for the overall chemistry of the ocean are just beginning to be recognized.

Finally, spectacular chemical phenomena associated with hydrothermal fluids at the spreading centers continue to draw attention. There is growing appreciation of the importance of these phenomena and their effect on chemistry of the entire ocean. Discovery of hydrocarbons emanating from sediments and of active sulfide mineral deposition in these regions may sustantially increase popular interest in marine chemical research.

Contents: IUGG Quadrennial Report
Chemical Oceanography

Marine Chemistry and Paleo-Oceanography in the United States, 1979–1982, An Overview, *D. R. Schink*
Advances in Marine Chemistry 1979–1982, *W. J. Jenkins and J. M. Edmond*
Review of Marine Organic Geochemistry, *R. B. Gagosian*
Paleo-Oceanography: Global Ocean Evolution, *J. P. Kennett*

Solar-Planetary Relationships: Cosmic Rays 1979–1982

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The reviews of cosmic ray studies (1970–1982) cover a broad area reflecting the present scope of this discipline. Cosmic ray physics transcended the narrow restricted specialties of composition, flux, and modulation long ago. In fact, the cosmic ray energy regime appears to be anything above "thermal" (a remark attributed to Professor Bruno Rossi). At the present time, the relationship of cosmic ray studies to solar-terrestrial physics encompasses an extremely wide range of interrelated and associated astrophysical phenomena from the sun to the interplanetary medium and throughout the domain of the heliosphere. Because solar-terrestrial and astrophysical processes impress their signature on the cosmic ray flux, it is quite natural to look for these effects in the cosmic radiation data. For this reason, the reviews associated with cosmic rays cover solar activity, shocks and associated structure in the interplanetary medium, composition and modulation, and long-term effects.

In this author's opinion the most noteworthy accomplishment in the quadrennium 1979–1982 was achieved from a measurement made on board the Solar Maximum Mission (SMM) satellite. The many long hours of searching for the hypothesized solar-flare-generated neutrons was climaxed by pure serendipity—solar neutrons were convincingly observed not by an experiment expressly designed to search for these elusive particles, but by the Gamma Ray Spectrometer on the SMM. Since the initial observation, on June 21, 1980, a second event, on June 3, 1982, gave rise not only to solar neutrons being measured at satellite altitudes but also to a time-coincident, extremely short increase in the counting rates of three ground-level neutron monitors (Chupp and Flückiger, private communication). The solar and interplanetary implications of this recent discovery will be exploited in the next quadrennium.

Studies in solar physics were dominated by the multi-national experiments on board the SMM and the coronagraph measurements on the P78–1 satellites. During this past four-year period the emphasis of the solar community gradually shifted from the active region analyses performed using the Skylab data to analyses of the impulsive phase of flares. Arguments on the first- and second-stage acceleration continue to wax and wane. However, the solar gamma-ray and associated solar neutron measurements, as well as studies of relativistic proton onset measurements during groundlevel cosmic ray events observed at 1 AU, show that rapid (i.e., less than one minute) particle acceleration to very high energies is possible.

The number of observations of coronal transients was greatly enhanced with the coronagraph measurements on the SMM and P78–1 satellites. The SMM coronagraph was a state-of-the art instrument intended for high resolution measurements and was operated in a highly coordinated manner in an effort to obtain simultaneous observations of coronal mass ejections, eruptive prominences, flares, and solar radio burst positions. These intensive coordinated studies have shown that while some of the coronal transients start in the corona simultaneously with a flare, others begin to accelerate outward prior to the flare onset. The possibility that there is "forerunner activity" in the region of subsequent mass ejection is an intriguing concept that should be exploited in the next four-year period. Other results show that the shock waves that excite type II bursts do not necessarily follow the same trajectory as coronal transient loops

The coronagraph on the P78–1 satellite was a less sophisticated instrument and was operated in a patrol mode over a longer period of time. The observed frequency of coronal transients is higher for the P78–1 observations than it was for the Skylab observations, but this is the result of a more sophisticated digital imager/background subtraction technique employed for the P78–1 data analysis which could not be duplicated with the Skylab photographs. Preliminary results using P78–1 and Helios data indicate a correlation between coronal mass ejection and interplanetary shocks. A series of SMM workshops is planned for 1983. The analysis of the measurements of the SMM, P78–1, and other related observations together with theoretical studies should provide significant improvements in our understanding of the sun and the processes that give rise to solar-initiated disturbances at the earth.

Physicists interested in solar particles usually start their studies with the acceleration and release of these particles at the sun, continuing with their propagation through the interplanetary medium to their ultimate detection either by satellites in the inner heliosphere or by the space probes traveling to the distant planets. It is generally thought that there is a significant transport of solar particles through the solar corona and then outward along the interplanetary magnetic field lines to an observation point, but it has proven extremely difficult to separate coronal propagation effects from the effects of interplanetary propagation. To complicate this matter, there is increasing evidence that the acceleration and/or injection of these solar particles into interplanetary space extends over finite periods of time lasting as long as a few hours. Recent results suggest that the "preferred connection or fast propagation region extending approximately plus or minus 50 degrees from the flare site" may be a consequence of the flare shock propagating across the corona and directly accelerating particles on the interplanetary magnetic field lines. These coronal shocks are also seen as candidates for particle acceleration.

With solar particle measurements now being made at various distances from the sun, we have a better opportunity to separate the interplanetary propagation characteristics from the solar processes. However, the processes involved are complex. Even during solar minimum, interplanetary space is not a quiescent transport medium, but is a complex structure of magnetic irregularities through which transient disturbances propagate. Thus, solar particles enroute from the sun to an observation point may pass through a myriad of regimes. Since the values of the diffusion coefficient for particle transport perpendicular to the interplanetary magnetic field are generally accepted to be very small, much of the recent work has concentrated on the parallel diffusion coefficient and the mean free path length of solar particles. Historically, a Fokker-Planck cosmic ray transport tensor equation has been most often used to model interplanetary particle transport, and indeed, both analytic and numeric solutions of the transport equation have been successfully fit to many solar cosmic ray events. However, the derivation and use of the classical transport equation has been attacked primarily because the values found for the mean free path length, λ, are not small compared to 1 AU, and the large mean free path lengths and the apparent lack of rigidity dependence in λ at low rigidities do not match theoretical predictions based on measured properties of the interplanetary field fluctuations. Difficulty has also been encountered in simultaneously fitting onset and decay phases of selected events. At the present time it appears that for particles less than 1 GV, the mean free path length along the interplanetary magnetic field line is greater than or equal to 0.1 AU. Some confusion has arisen in the use of the term "scatter-free events." In this author's opinion, the use of this term was perhaps unfortunate as it implies there is no scattering. What is actually meant is that for some events the mean free path length is relatively large, greater than 1 AU, compared to the majority of events where the mean free path length may be of the order of 0.1 AU, and that for some measurements near 1 AU the scatter-free approximation fits the data almost as well as the much more elaborate formulations.

Several studies have focused on the slopes and shapes of electron, proton, alpha, and heavier particle species over extended ranges of energies. One of the objectives of such studies is to minimize the effects of interplanetary propagation in order to get as close to a solar source spectrum as possible. The electron source spectra have been found to have the same general shape, a double-power law in energy with a smooth transition around 100–200 keV. The proton and alpha source spectra are not, in general, power laws, but are instead curved in a way similar to exponentials in rigidity. Although the exponential approximation for the source spectrum is convenient and useful, these ion source spectra are better fit by a more complex Bessel function.

Analyses of individual events as observed by a single spacecraft continued. Unfortunately the analyses of multi-spacecraft data together with related solar observations are so few that it is not yet possible to clearly identify selected patterns in the results. In the next four-year period there should be a significant increase in the multi-spacecraft coordinated event analysis that may give rise to a more comprehensive and encompassing model of solar particle acceleration/injection and propagation.

There has been a rapid acceleration of research activities concerned with the understanding of the close association between energetic particles and shocks in the heliosphere. This research has been spurred by the detailed measurements from the array of spacecraft ranging in heliocentric radial distances from 0.3 AU to more than 25 AU.

"Shocks" come in many shapes and sizes and include the earth's and other planetary bow shocks, shocks formed by corotating interaction regions, and shocks initiated by solar flares or other transient solar activity. In addition the proliferation in terminology is shocking. There are collisionless shocks, traveling shocks, corotating shocks, standing shocks, "shock-spike" events, "pre-shock" and "post-shock" enhancements, energetic storm particle events, and more. All these phenomena have been observed from 0.3 AU to 25 AU.

The increased observations and the theoretical work on the energetic particles up-

Article (cont. on p. 474)

U.S. National Report to IUGG 1979–1982

Eos is periodically publishing the 13 overviews appearing in the *U.S. National Report to the International Union of Geodesy and Geophysics 1979–1982*. The U.S. National Report was published by AGU on behalf of the U.S. National Committee in four extra issues of *Reviews of Geophysics and Space Physics* (RGSP). The discipline overviews appearing here were published with their associated papers (see Contents list at the end of each overview).

Subscribers to RGSP will automatically receive the four extra RGSP issues containing the U.S. National Report, which were mailed in June 1983. The four regular issues of RGSP are appearing as usual in February, May, August, and November. Those who do not subscribe to RGSP can still obtain the entire U.S. National Report by entering a subscription to RGSP. In addition, the report of each discipline is automatically mailed separately to those members of AGU for whom that discipline is their primary AGU section affiliation; this separate distribution is made possible by grants from the Defense Mapping Agency, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Science Foundation, Office of Naval Research, and U.S. Geological Survey.

Article *(cont. from p. 473)*

stream of, and associated with, the earth's bow shock is primarily because of the unprecedented comprehensive and detailed measurements made by the ISEE spacecraft system. Excluding the "magnetospheric bursts" (covered in the magnetospheric section), the upstream ions are generally divided into two populations: "reflected" ions, which are highly anisotropic, streaming along the interplanetary magnetic field away from the bow shock, and "diffuse" ions, which are approximately isotropic in the frame of the spacecraft near the bow shock. The two populations seldom coexist. Each population has a number density ~ 1% that of the solar wind, and the particles are observed only when the spacecraft is magnetically connected with the bow shock. This accounts for the "on again–off again" type of measurements that are correlated with the motion of the interplanetary magnetic field lines. The "reflected" ions extend from solar wind energies up to several keV with a peak intensity generally at ~ 4–5 keV with a sharp decay at higher energies. The "diffuse" ions extend from solar wind energies up to 100–200 keV, also with a peak at ~ 4–5 keV. Above ~ 30 keV they exhibit differential intensity spectra that have an exponential form with energy. In addition to these ion measurements, there are measurements of composition, spectra, and anisotropies as a function of time, distance and species, studies of individual events, and studies associated with hydromagnetic wave measurements.

It is no wonder that with this bewildering array of measurements the theorists have had a field day. (It is an observational fact that theorists require very little time to accommodate new definitive measurements.) Work has been done on different shock acceleration mechanisms considering the special cases of parallel and perpendicular shocks, and some plausible scenarios have been postulated. A self-consistent theory for the diffuse ions and hydromagnetic waves in the "equilibrium" configuration in which the solar wind velocity and the interplanetary magnetic field are nearly parallel has been developed. In addition to the energetic ions associated with the earth's bow shock, studies have been made of similar observations with the planetary bow shocks of Mercury, Venus, and Jupiter.

Corotating ion intensity enhancements associated with corotating interaction regions were also extensively studied over the past four years. These studies, at different heliocentric distances, indicate that particle acceleration in shocks continues at distances greater than 1 AU. One detailed study of a long-lasting corotating interaction region that persisted for more than 14 solar rotations revealed that 50–60% of all identified shocks are accompanied by time-coincident proton intensity enhancements. Corotating events are not limited to the ecliptic plane and have been observed by Pioneer 11 located at greater than 15° solar latitude. In addition, both observational data and theoretical studies indicate that corotating interaction regions affect the interplanetary propagation of galactic cosmic rays.

Large solar flares generally produce shock waves that propagate out through the solar corona and solar wind into interplanetary space. These shock waves often play a major role in the time evolution of the solar cosmic ray interplanetary transport between the sun and the earth. The passage of interplanetary shocks near 1 AU is often accompanied by energetic storm particle events, "shock spike" events, and "post-shock" enhancements. Most work during the past four years has concentrated on energetic storm particle events. The ions gradually increase in intensity prior to shock passage, peaking in intensity at the shock, with a characteristic time scale that increases with energy from ~ 5 minutes at 30 keV to ~ 10 hours at 1 MeV. The ion intensity enhancement is often continuous at the shock, providing some evidence that energetic storm particle events and post-shock enhancements should be viewed as one phenomenon.

The modeling of traveling interplanetary shocks has gained in importance over the past four years, greatly aided by the dekametric radio measurements on ISEE-3. It is felt that this work will gain in importance in the near future as scientists try to model these solar initiated disturbances as they leave the sun and propagate outward through the interplanetary medium to a detection location.

Substantial progress has been made in the study of the composition of solar particles and the elemental and isotopic composition of galactic cosmic rays. In both cases this progress is primarily the result of the improved instrumentation available. Measurements of cosmic ray elemental and isotopic composition are of importance in understanding the origin, acceleration, and propagation of cosmic rays.

Solar cosmic ray abundances, particularly in the range 1–20 MeV/nucleon, differ from accepted solar photospheric and universal abundances in specific and systematic ways. In particular the elements Na to Si are enhanced relative to oxygen, O, by roughly a factor of 2 over accepted solar values, an effect duplicated in computed source galactic cosmic ray abundances. The observed abundance differences between solar cosmic ray and solar photospheric or universal abundances can be organized roughly, as can galactic cosmic rays, by elemental first ionization potentials, although what this correlation represents is not clear. Other results confirming earlier studies show that some large flares are enhanced in heavy elements, with the magnitude of the enhancements increasing with increasing atomic number and/or weight in a roughly monotonic fashion. In the past few years measurements of solar cosmic ray isotopic abundances have been made. Of the elements studied so far (C, N, O, Ne, Mg) the abundances found are consistent with universal or solar abundances except for Ne.

The unprecedented statistics and improved instrumentation on balloon-borne instruments and on the HEAO-3 spacecraft gave rise to hitherto unavailable precision in the measurements of galactic cosmic ray abundances. The abundances of all the elements from H to Ni have now been measured, and comprehensive observations of individual elements have been made from ~ 0.1 to ~ 20 GeV/nucleon. Some of the more abundant elements have been measured up to ~ 100 GeV/nucleon. A comparison of differences in elemental abundances between the galactic cosmic ray sources and the local solar system sources, as well as the differences in abundances between the solar energetic particles and the solar system sources, suggests that atomic rather than nuclear processes are mainly responsible for the differences between these compositions.

Measurements of ultra-heavy nuclei are important as they provide new tests of models of cosmic ray origin and propagation. Individual ultraheavy elements can be studied from measurements on the HEAO-3 satellite. At the present time even-Z nuclei through Z = 56 have been resolved. It is anticipated that even-Z elements through Z = 82 can be identified in future analysis of the HEAO-3 data.

Previous studies employing the then best available, but still very poor abundance ratios, had concluded that the long-lived radioactive elements, such as $_{92}U$, were overabundant by a factor of ~ 10 when compared to solar system material; however, greatly improved abundance results from the HEAO-3 experiment show that the actinide abundances are significantly lower than the previous estimates.

The high resolution measurements of cosmic ray isotopes on the ISEE-3 spacecraft have already altered our views of both cosmic ray origin and propagation. The cosmic ray isotopes contain a detailed record of their nuclear history including their synthesis in stars and subsequent high energy nuclear interactions with the interstellar gas, whereas the elemental distribution appears to be determined largely by atomic interactions. New results show that the isotopic composition of cosmic ray material differs from that of solar system material and that nucleosynthesis differences must be included on the list of processes that have shaped the cosmic ray composition.

In the next four-year period the measurements of the HEAO-3 and ISEE-3 spacecraft will continue to be painstakingly analyzed. This is the "dogwork" of data analyses that, when completed, will make the new discoveries sound routine.

Probably the most intriguing event of the past four years relating to cosmic ray composition was the disappearance of the anomalous component at 1 AU. The "anomalous component" is an increase in the flux of low-energy, low-Z particles above the "normal cosmic ray spectrum." Observed in cosmic ray measurements from 1972 through 1979, this anomalous component may be perhaps a function of the reversal of the sun's magnetic polarity.

The extent of the heliosphere continues to remain a question as space probes travel further from the sun. Pioneer 10 reached a distance of more than 29 AU in 1982 and continued to measure Forbush decreases and other modulation effects propagating outward with approximately the solar wind speed. From the many studies being done using these distant particle data, it appears that the boundary of the heliosphere extends to at least 50 AU and possibly beyond.

Spacecraft measurements of the solar wind, interplanetary magnetic field, and energetic particles have been made since 1965, thus covering one 11-year period from solar maximum to solar maximum. In the past four years there has been substantial progress made in the efforts to deduce the behavior of the solar wind on the time scale of decades to hundreds of years. Work on this "solar wind archaeology" will probably continue attempting to deduce the solar wind/solar cycle/solar variation behavior. The solar cycle variations in the solar wind are not blatantly obvious in the limited in situ interplanetary observations available since 1965; however, studies of the "solar wind archaeology" indicate that changes in the sun and the solar wind at the earth have occurred in the past. These changes take place on time scales of several years to hundreds of years. Although the precise quantitative data that can be deduced is limited, the work during the past four years has demonstrated that good scientific data sets can be deduced by independent means and that these data sets can be compared, cross calibrated, and analyzed. Eventually this type of work may lead to a better understanding of the long term variation in solar activity, why and how the sun changes to produce these effects at the earth and in space, and when the next major change will take place. To aid in long term historical studies such as these, the American Geophysical Union recently organized a committee on history that includes the preservation of scientific data from both old and modern sources as part of its charter.

Finally, it should be noted that the IUPAP Cosmic Ray Commission conducted two international cosmic ray conferences during the past quadrennium, in Kyoto, Japan, in 1979 and in Paris, France, in 1981. At the conclusion of each conference, leading scientists were invited to give a "conference summary" of the outstanding advances in their areas of expertise since the previous conference. These rapporteur papers are published in the conference proceedings and offer an excellent concise view of the current state of cosmic ray physics.

In summary, cosmic ray physics has continued to evolve over the past four-year period with the availability of new observations from improved instrumentation on satellites in addition to measurements extending from 0.3 to 29 AU. There have also been improvements in the theoretical work necessary to understand new and significant observations. In the next four-year period significant advances should be made in the following areas: solar-induced traveling shocks, galactic and solar cosmic ray elemental and isotopic abundances, and the cosmic ray environment in the distant heliosphere. Coordinated multispacecraft data analyses hold great promise for future advances in understanding the entire particle transport problem—both the galactic cosmic rays diffusing inward in the heliosphere and the solar cosmic ray fluxes propagating outward through the heliosphere.

Contents: IUGG Quadrennial Report
Solar-Planetary Relationships: Cosmic Rays

Overview of Cosmic Ray Studies and Associated Topics (1979–1982), *M. A. Shea*
The Elemental and Isotopic Composition of Galactic Cosmic Ray Nuclei, *R. A. Mewaldt*
The Composition, Propagation, and Acceleration of Energetic Solar Particles: A Review of United States Research 1979–1982, *R. E. McGuire*
Cosmic-Ray Modulation and the Anomalous Component, *F. C. Jones*
The Association of Energetic Particles and Shocks in the Heliosphere, *M. A. Lee*
Solar Cycle and Long Term Changes in the Solar Wind, *J. Feynman*
Solar Activity, *D. M. Rust*

Tectonophysics 1979–1982

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Studies in tectonophysics are becoming increasingly interdisciplinary. Hence there was an attempt in this report to concentrate on subjects that have attracted particularly broad interest during this quadrennium, rather than concentrating on the activities of the individual disciplines.

One of the strongest debates during this period has been on the state of stress in the lithosphere, reported on by M. Zoback. This debate has centered on the conflict between the low heat flow over the San Andreas fault, which suggests very low stresses, and the experimentally determined laws of rock friction, which suggest the opposite. Other lines of evidence, such as that of shear heating in ductile shear zones, in situ stress measurements, and strengths necessary to support flexure of the lithosphere, and paleopiezometry have also been brought into the debate, all of which seem to support the latter point of view.

A somewhat related topic, "Rheology of the Lithosphere," is reported on by S. Kirby. Kirby's report concentrates, however, more on experimental studies of the flow laws in the various flow regimes of the crust and upper mantle, including studies of friction and brittle fracture. He points out the recently emphasized role of water in these rheological properties, and, to a lesser extent, the evidence from flexure of the lithosphere.

Experimental and theoretical studies related to the earth's mantle and core are reported on by R. Jeanloz in "Mineral and Melt Physics." He reports on experimental studies of high pressure phase equilibria and physical properties of minerals at high pressures as determined by both static and shock methods. He also discusses new molecular theories used to predict such properties and some of the new experimental techniques used to measure them.

One of the main processes to which these measurements may be eventually applied, mantle convection, is discussed in a report by A. Boss. Much of the work on convection is theoretical, and though hampered by the complexity of the complex geometry, chemistry, and rheology of the mantle, is producing insights into the process. Boss reviews the geophysical and geochemical evidence and constraints on mantle convection and discusses the debate between whole mantle and upper mantle convection protagonists.

W. Pitman reviews an area of very active research, that of the evolution of passive continental margins and interior basins. He discusses much of the work that has been done on modeling these features, which includes their thermal evolution, flexure, and response to sedimentary loading. Widespread stratigraphic correlations, which may correspond to eustatic sea level changes, are also discussed.

Although observations concerning recent crustal movements are reported in another section of this volume, J. Rundle reports on work concerning modeling of this deformation. Much of this work has concentrated on the response of the earth to large earthquakes, both of strike-slip and thrust type. Certain controversy has arisen over the role of the mantle in the process. Other modeling studies have concerned themselves with the entire earthquake cycle, particularly for strike-slip earthquakes. Models of observed data for specific examples of earthquakes are briefly discussed.

Processes at spreading centers has been a particularly active topic and is reviewed by K. MacDonald. He discussed the recent discoveries of shallow magma chambers beneath mid-oceanic ridges and of the hydrothermal vents known as "Black Smokers." He points out that major differences appear to exist between slow and fast spreading centers, including the width of the zone of intrusion. He discusses various debates and observations concerning the development and variations between mid-oceanic rifts and how they may propagate.

The recent recognition of accreted terranes, i.e., allochthonous regions ranging from tens to hundreds of kilometers that may have been emplaced from thousand km distances, is reviewed by A. Nur. Although still a controversial subject, stratigraphic and paleomagnetic results appear to verify that such terranes are not uncommon, particularly in some regions like Alaska. The origin and timing of the emplacement of such terranes is still a matter of great debate.

L. Seeber reviews "Thin-Skin Tectonics," a recently reviewed field in which deep seated low angle thrust, or detachments, plays a major role in tectonics. Deep seismic sounding, such as by COCORP, has revealed such features, but it is as yet uncertain as to how widespread or important they are in tectonics.

The following reviews are necessarily brief: those interested in particular subjects are referred to the extensive citation lists provided.

Contents: IUGG Quadrennial Report
Tectonophysics

Tectonophysics—1979–1982, *C. H. Scholz*
Crustal Processes at Spreading Centers, *K. C. Macdonald*
Models of Crustal Deformation, *J. B. Rundle*
Rheology of the Lithosphere, *S. H. Kirby*
Mineral and Melt Physics, A Summary of Research in the United States, 1979–1982, *R. Jeanloz*
State of Stress in the Lithosphere, *M. D. Zoback*
Convection, *A. P. Boss*
Passive Continental Margins, A Review, *W. C. Pitman III*
Large Scale Thin-Skin Tectonics, *L. Seeber*
World Data Center-A Activities, 1978–1982, *J. F. Lander*

News

Acid Rain Reports

Three independent reports on acid precipitation issued in June reinforce each other and, taken together, support those seeking immediate action to curb man-generated acid deposition in northeastern North America by reducing emissions of sulfur and nitrogen oxides. The Interagency Task Force on Acid Precipitation report concluded that man-made pollution is to blame for acid precipitation problems in the northeastern United States. A National Research Council (NRC) committee stated that reducing the man-made emissions of sulfur and nitrogen oxides will result in a proportional reduction in the deposition of acid precipitation. And an acid rain panel assembled by the White House Office of Science and Technology Policy (OSTP) called for immediate action to curb the emissions despite incomplete scientific data.

Early in June, in its first annual report to President Reagan and Congress, the interagency task force concluded that, "Man-made atmospheric pollutants are probably the major contributors to acid deposition in northeastern North America." Natural sources, while contributing "significantly to the acidity of precipitation in some areas, such as the southeastern United States," are believed to play only a minor role in the northeast, according to the task force's preliminary findings. Christopher Bernabo, a former AGU Congressional Fellow, is the executive director of the task force, which represents 12 federal agencies.

The report outlines the National Acid Precipitation Assessment Program's progress on acid precipitation research (*Eos*, February 24, 1981, p. 76) and the outlook through fiscal year 1985. Among the project goals the report expects to be accomplished in the coming two years are completion of a major transport experiment to help determine long-range pollutant transport patterns; completion of a broad assessment on the potential effects of acid deposition on soils; the application of advanced models to predict utility emissions and development of a preliminary model to estimate industrial combustion emissions; completion of assessments of the potential significance of alkaline dusts and natural sulfur and nitrogen emissions in influencing precipitation acidity over sensitive regions; and development of a model capable of estimating local/mesoscale atmospheric deposition.

The task force did not address how acid deposition may be scaled back by emissions reductions: "Current data and available methods. . .are not sufficient to quantify relationships between pollutant emissions and acid deposition on a regional scale or under varying conditions." This is where the NRC report picks up.

Reducing man-made emissions of sulfur and nitrogen oxides will result in a proportional reduction in the deposition of acid precipitation, according to the NRC Committee on Atmospheric Transport and Chemical Transformation in Acid Precipitation. "We find no evidence for a strong nonlinearity in the relationship between average emissions and depositions in eastern North America."

The committee of eight scientists, which released its report—*Acid Deposition: Atmospheric Processes in Eastern North America*—at the end of June, based its findings on historical data taken at the Hubbard Brook Experimental Forest in New Hampshire, on the ratio of amounts of sulfur dioxide and nitrogen oxides in emissions, and on the ratio of the products deposited as sulfate and nitrate in precipitation. The committee concluded that "within the uncertainties and for annual averages and summed over large areas of the eastern North America, the relationship between emissions and deposition can be taken for practical purposes as essentially linear." Jack G. Calvert of the National Center for Atmospheric Research chaired the committee.

The committee was unable, however, to determine source-receptor relationships (where deposition would be reduced as a result of cutting emissions from a specific location). "Our findings, therefore, have limited applicability to the analysis of alternative control strategies." (The interagency task force also found "current generation models" for predicting source/receptor relationships lacking adequate resolution and accuracy.) The NRC group also called for more field studies to develop more accurate models to address the source/receptor relationship.

"We believe the report demonstrates that if the emissions in eastern North America were reduced uniformly, the result would be a proportional reduction in the long-term average acid deposition within the region. We do not intend by this statement to imply that the policy of uniform emissions reduction is the best one to adopt," Calvert cautioned during a press conference when the report was released. "Obviously, any control policy decision should be based upon economic and benefit analysis of alternative control strategies."

The Reagan Administration has insisted that no emission control strategies be employed until there was more hard scientific evidence that such controls clearly would result in reductions of acid precipitation. However, the findings of the NRC committee, coupled with those of the interagency task force and the OSTP panel, could prod the administration into prompt action. Environmental Protection Agency Director William D. Ruckelshaus reportedly is drafting an acid precipitation plan.

Two days before the release of the NRC report, the OSTP Acid Rain Peer Review Panel counseled immediate action to curb acid precipitation. "The overall scientific understanding of the various aspects of acidic precipitation is quite incomplete at the present time, and will continue to have major uncertainties well into the future. . .Recommendations based upon imperfect data run the risk of being in error; recommendations for inaction pending collection of all of the desirable data entail even greater risk of damage," the panel said in a summary of its complete report, which will be ready this autumn.

"It is in the nature of the acid deposition problem, that actions have to be taken despite incomplete knowledge," the panel went on to say. "If we take the conservative point of view that we must wait until the scientific knowledge is definitive, the accumulated deposition and damaged environment may reach the point of 'irreversibility.'"

The panel believes that "the proper initial approach is to select particularly economically effective steps to begin to reduce our concerns in the light of gross transport and deposition features that have been identified, associated with seasonal and geographical variation." One first "least cost" step, offered by the panel as an example, "might be gross reductions in sulfur emissions from nonferrous smelters and intensifying coal washing."

OSTP's acid rain panel said it might be possible to develop a model for the source/receptor relationship for eastern North America sometime in the next 10 years, but not for at least another 5 years.

The panel, chaired by William A. Nierenberg, Director of the Scripps Institution of Oceanography and an AGU Fellow, was charged by Presidential Science Advisor George A. Keyworth, II, with reviewing the "state of knowledge" on acid rain.—*BTR*

EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

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Cover. This photograph of the total solar eclipse of June 11, 1983, was taken by L. Lacey and M. McGrath of the National Center for Atmospheric Research High Altitude Observatory (HAO) from a site on the north coast of Java. Of particular interest is the huge helmet streamer extending to more than 3.5 solar radii above the disk at the southeast limb of the sun. The HAO white light coronal camera, which has been used at a number of eclipses since 1966, uses a radially graded filter to enhance the visibility of the coronal fine structure and to widen the effective field of view. (Photo courtesy of Richard Fisher, HAO, P.O. Box 3000, Boulder, CO 80307.)

USGS To Accept Private Funds

The U.S. Geological Survey (USGS), the federal government's largest earth science research agency, is now authorized to accept contributions from private sources and to collaborate with such sources in projects that support the agency's scientific research and its development of technology and data systems.

Before the USGS can accept outside contributions, however, the proposed project must be deemed to be in the public interest and must be deemed compatible with the basic USGS mission. Among the responsibilities of the USGS, are assessing the nation's land, water, energy, and mineral resources and developing methods to define and mitigate hazards associated with earthquakes, volcanic eruptions, and landslides. Details on criteria and procedures for making contributions and entering into collaborative projects are outlined in the June 2 *Federal Register*.

Upon final acceptance of a contribution or collaborative project, the USGS will place an announcement in the *Federal Register* to inform the public of the amount and purpose and to invite additional contributions or participation, if appropriate. The USGS will prepare and make available to the public, reports on the results of all projects conducted with contributions from private sources.

Individuals and organizations wishing to make contributions to or enter into collaborative projects with the USGS should submit proposals to Dallas Peck, Director, U.S. Geological Survey, Mail Stop 101, National Center, Reston, VA 22092. Technical questions should be directed to Bruce B. Hanshaw, Assistant Director for Research (telephone: 703-860-7488).

Space Telescope Will Meet Specs

Space Telescope will not fly on schedule as originally proposed, but it will meet specifications, according to Administrator James Beggs of the National Aeronautics and Space Administration (NASA) (*Nature*, June 23, 1983). Late 1986 is now the target date for a Space Shuttle launch.

Space Telescope, whose recently opened earth-based laboratory is located on the Johns Hopkins University campus in Baltimore, Md., will have to perform to unusually exact tolerances in order to gain an advantage over the world's large telescopes. Even though clear of atmospheric sources of light contamination, Space Telescope must have high resolution and be free of any jitter while traversing earth orbit. Meeting these requirements has been difficult, as might be expected for such advanced design specifications.

The Perkin-Elmer Corporation, prime contractor for the reflector dish, has by some standards made unusual progress; but delays due to the problem of constructing the telescope under conditions which are unlike those in space have cost time and money. The first tests of the coated reflecting surface of the telescope dish showed distortion due to gravitational acceleration at the earth's surface, which will not occur at close to zero G while in orbit. Dust, which would degrade UV resolution, has been found on 0.2 percent of the surface, causing another problem in preparing for flight. Other mechanical problems that must be solved include vibrations in guidance control systems.

Three years remain before the first possible launch date of Space Telescope, enough time to collect more dust and contamination. Methods of cleaning the mirror surface by blowing purified jets while the mirror is facing downwards will be attempted; the problems, it seems, can be solved.

The probable delays will involve additional costs. Geophysicist Thomas M. Donahue, who is chairman of the National Research Council's Space Science Board, state recently, "While the Telescope is the highest-priority mission in space science, it would be short-sighted to finance overrun on the Space Telescope from other scientific problems." (*Physics Today*, June 1983). The overruns are estimated by Donahue to be on the order of 50% over the total budgeted figure of about $500 million to construct and fly Space Telescope. The overruns will probably be included in NASA's appropriations, however, and will not affect other parts of the space program.—*PMB*

World Petroleum Supplies

A number of conclusions by political conservatives about the fate of world petroleum supplies have been emerging lately. Among the most recent of them arose from discussions, held at the 1983 spring meeting of the American Association for the Advancement of Science (AAAS), which focused on the environment and resource study entitled "The Global 2000 Report" (*New Scientist*, June 9, 1983). Fred Singer, representing the Heritage Foundation of Washington, D.C., criticized the report, which predicted shortages in the near future, saying that the current world-wide oil glut will continue beyond the year 2000. Alternatives to the use of petroleum are a part of the cause. Singer argued that conservation, nuclear energy, and other petroleum substitutes will continue to suppress the demand for petroleum. In addition, according to other evaluations, exploration for petroleum and natural gas has not really begun.

John M. Hunt, senior scientist at Woods Hole Oceanographic Institution, a while ago made the following observations. "One of the most revealing studies on [petroleum resources] was published by a U.S. Geological Survey research geophysicist, F. F. Grossling. He pointed out that about 2½ million exploratory and development wells have been drilled in the United States compared to about a half million in the rest of the free world. Even the Middle East with its huge reserves has fewer than 50,000 wells. The sedimentary basin area of the rest of the free world is about 6 times greater than that of the United States. If this area were as heavily drilled as sites in our country there is no doubt that there would be enough oil or gas to last until the end of the next century. Furthermore, these areas include only the continents and continental shelves. If the continental margins (slopes and rises) are added, conceivably the quantity of oil and gas resources existing on the continents and shelves could be doubled. This addition would ex-

News *(cont. on p. 476)*

News *(cont. from p. 475)*

tend free-world resources for at least 200 years." (*Oceanus*, Summer 1981).

A version of the formerly environmentalist-leaning "Global 2000" as revised by conservatives was released at the AAAS meeting and described in a report entitled "Conservatives debunk environment." The revised conclusion now is that there will be no shortage of oil by the year 2000. The report quotes Herman Kahn, founder of the Hudson Institute, who called the original report's warning of a disaster in the Third World if current trends continue as being "insidious and invidious nonsense."—*PMB*

Geophysicists

Guust Nolet of Utrecht University has been awarded the 1983 Vening Meinesz prize for his seismological research. The award was instituted in 1962 by F. A. Vening Meinesz.

Irwin I. Shapiro, director of the Center for Astrophysics, Harvard-Smithsonian Observatory, has won the 1983 Dannie Heineman Prize for Astrophysics. The joint American Institute of Physics–American Astronomical Society annual prize recognizes, according to the award's citation, Shapiro's "imaginative application of the techniques of radar and radar astronomy to the study of the solar system and to the experimental tests of the general theory of relativity." The prize carries with it a $5000 prize.

John Wahr of the physics department at the University of Colorado in Boulder has been selected by the International Association of Geodesy (IAG) in consultation with the Geodesy Subcommittee of the Royal Society to receive the 1983 Guy Bomford Prize for Geodetic Research. The award will be conferred during the opening session of IAG at the 18th General Assembly of the International Union of Geodesy and Geophysics in Hamburg, F.R.G., August 15.

Richard J. Wold has been appointed Chief Geophysicist/Marketing Manager of the Geophysical Services Division of EG&G Geometrics in Sunnyvale, Calif. Wold will be responsible for providing geophysical support, including magnetic and radiometrics survey techniques, to the exploration industry, and for promoting mapping, data processing, interpretation, and the use of the new transverse gradiometer survey system.

Books

Principles of Geochemistry

B. Mason and C. B. Moore, 4th ed., *Smith and Wyllie Intermediate Geol. Ser.*, John Wiley, New York, v + 344 pp., 1982.

Reviewed by B. Ronald Frost

Geochemistry is one of those broad fields of study that is difficult to define to the satisfaction of all those who work in it. One widely accepted definition is the traditional Goldschmidtian approach that considers geochemistry to be a study of the geological and chemical controls on the distribution of the elements within the earth. This is the definition of geochemistry that is implicit in the approach taken by this book. On the whole, the book does a commendable job in treating this aspect of geochemistry, although the quality of coverage for various subjects is far from uniform. For instance, the treatment of the distribution of major and trace elements caused by igneous processes is well organized and clearly written, whereas the chapter on metamorphic processes can only be described as excoriable. This is the fourth edition of a book that was first published in 1966, and, considering that the text deals with such long-dead issues as stress and antistress minerals, it seems to this reviewer that the chapter on metamorphic processes has not been updated since that date.

To many people working in the field of geochemistry, the science is best described as the application of chemical theories, such as thermodynamics and kinetics, to the solving of geologic problems. Mason and Moore make it clear in the introduction that their text is not designed to cover these topics in depth, and they proceed to cover all of thermodynamics in six pages. While, in theory, it may be possible to discuss the distribution of the elements in geologic environments without the aid of thermodynamics, in actuality the authors find it difficult to do so. Terms that have not been previously defined such as "law of mass action," "chemical potential," "equilibrium constant," and "activity" continually appear in the text. To a student who is not acquainted with thermodynamics, the use of these terms would be confusing to say the least.

Owing to the restricted aspects of geochemistry covered by the book, its value as a textbook is entirely dependent upon the nature of the geochemistry course the instructor wishes to teach. If the course is designed as a mere review of the distribution of elements in the earth's crust, then the book, though flawed, is entirely adequate. However, the book is not designed to provide an introduction to the geologic application of chemical thermodynamics and equilibrium calculations, and, therefore, it would be entirely inadequate to use for a text in a geochemistry course that is designed to cover such topics.

B. Ronald Frost is with the Department of Geology and Geophysics, University of Wyoming, Laramie, WY 82071.

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POSITIONS AVAILABLE

Research Scientist II. The Solar-Terrestrial Theory Group at the University of New Hampshire seeks applications for a research scientist II to undertake a variety of theoretical problems on plasma and MHD processes in the solar atmosphere and the solar wind, and related energetic particle phenomena.

Minimum qualifications: Applicant must possess a Ph.D. or equivalent professional degree, with research leading to doctorate, with training in theoretical space plasma physics or a related field, (e.g., theoretical plasma fusion research), or masters degree and at least three years of research experience which is closely related to project work. Salary range $20,110 to $31,260; normally starting salary not to exceed $22,510. Resume and three letters of reference should be sent before August 15, 1983, to: Dr. J. V. Hollweg, Department of Physics, University of New Hampshire, Durham, NH 03824.

The University is an affirmative action/equal opportunity employer.

Visiting Position in Structural Geology/Tectonics: University of Michigan. The Department of Geological Sciences invites applications for a one- or two-year visiting position at faculty rank, to begin September 1, 1983, or at the latest, January 1, 1984. A PhD is required and research interests in Structural Geology or Tectonics should match those of current faculty (Professors T. Lay, H.N. Pollack, L.J. Ruff, R. Van der Voo, and D.V. Wiltschko). Teaching responsibilities will be, on average, one course per semester; a structural geology course for undergraduate concentrators is among these and is offered in the winter semester. Minimum salary of $22,000/academic year or higher depending on experience. Interested persons should send a resume, names of three persons from whom the department may request letters of recommendation, and a brief statement of research interests to Rob Van der Voo, Chairman, Department of Geological Sciences, 1006 C.C. Little Building, Ann Arbor, MI 48109. The search will close August 10, but later applications will be considered.

The University of Michigan is a non-discriminatory, affirmative action employer.

Deputy Assistant Administrator for Ocean Services and Coastal Zone Management. The National Oceanic and Atmospheric Administration (NOAA) announces Senior Executive Service for Deputy Assistant Administrator for Ocean Services, location in Washington, D.C. Duties include providing scientific and technical leadership in the management, development and execution of National Ocean Service program policies and goals and the operation of programs of the component units. Pay rate for the SES position commensurate with background and experience; current salary range $56,945 p.a.—$67,200 p.a. Apply to NOAA/NOS, 6001 Executive Boulevard, Rockville, Maryland 20852, Attention: PER15:MMT.SF-171 must be received by August 19, 1983 to be considered.

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Iowa State University of Science and Technology, Department of Earth Sciences/Research Associate: Electron Microprobe. The Department of Earth Sciences invites applications for a Research Associate position as an electron microprobe specialist. The appointment will be a fully funded, permanent, twelve-month position. Salary will be commensurate with qualifications.

Primary duties are the operation and maintenance of a fully automated microprobe with WDS and EDS capabilities and the supervision of associated laboratory facilities. Additional duties include the instruction of research personnel in instrument operation. Ample opportunities exist for conducting collaborative and independent research involving the microanalysis of geological materials.

Applicants should have a M.S. degree in a science or engineering field, or equivalent experience, and experience with electron beam instrumentation. Persons with a working knowledge of WDS and EDS spectrometers and the accompanying computer operations and experience analyzing geological samples will be preferred applicants.

Application deadline is July 31, 1983. Later applications will be accepted if the position is not filled. Applications should include a complete resume, a statement of background and interests, copies of publications and names of at least three references. Applications should be sent to:

Bert E. Nordlie
Department of Earth Sciences
Iowa State University
253 Science I
Ames, Iowa 50011

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D'Appolonia/Senior Groundwater Hydrogeologist. D'Appolonia has an immediate opening in their Pittsburgh office for a SENIOR GROUNDWATER HYDROGEOLOGIST with an advanced degree in hydrogeological sciences and/or engineering and experience in hazardous waste projects. Expertise in report writing and ability to supervise hazardous waste projects is important; experience in field exploration techniques, project management, and a working knowledge of hydrologic simulation is required.

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Research Professor in Marine Geoscience/University of Rhode Island. The Graduate School of Oceanography invites applications for a research professorship in Marine Geoscience whose salary and rank are negotiable. Preference will be given to candidates who have clearly demonstrated abilities and interest in, but not necessarily limited to paleomagnetism. The position is funded by contracts and grants, however the research professor holds full faculty rights in addition to other benefits. The paleomagnetic facility at GSO is fully equipped, fully operational and oriented towards rapid measurement of large numbers of soft sedimentary samples. Applications are now open for the position which will become available about January 1, 1984.

Send letters of application, resume, and names and addresses of three professional references to: Roger L. Larson, Graduate School of Oceanography, University of Rhode Island, Narragansett, Rhode Island 02882.

An affirmative action/equal opportunity employer m/f.

Chief, Ocean Resources Assessment Division. The National Oceanic and Atmospheric Administration (NOAA) announces Senior Executive Service Vacancy for Chief, Ocean Resources Assessment Division, Office of Oceanography and Marine Services, National Ocean Services, location in Rockville, Maryland. Duties include providing scientific and technical leadership in the management, development, and execution of major programs in oceanography and related sciences including ocean waste disposal, offshore oil and gas operations, marine transportation and deepwater ports. Pay rate for this SES position commensurate with background and experience; current salary range $56,945—67,200 per annum. Apply to NOAA/NOS, 6001 Executive Boulevard, Rockville, Maryland 20852, Attention: AT/PER15LT. Standard Form 171 "Personal Qualifications Statement" must be received by August 19, 1983 to be considered.

Equal Opportunity Employer.

Oceanographers. Assistant Professor, tenure track position for applicants with recent Ph.D. and competence and interest in marine radioactivity and trace metal biogeochemistry. Duties will include development of research projects and some teaching. Salary negotiable depending upon experience and qualifications. Submit resume and names and addresses of three references by 1 September 1983 to: G. Ross Heath, Dean, School of Oceanography, Oregon State University, Corvallis, OR 97331.

An AA/EEO Employer.

Research Scientist/Atmospheric Science/MIT. The Center for Meteorology and Physical Oceanography at MIT seeks applications from new or recent Ph.D.'s in atmospheric sciences for a research position involving the interpretation of NIMBUS-7 and SAGE satellite data on stratospheric trace gases and aerosols. The general aim is to improve our understanding of stratospheric chemistry and of the three-dimensional and residual-mean two-dimensional transport of tracers in the upper atmosphere. Appointment duration is one to three years. Familiarity with computing techniques used in multi-dimensional atmospheric circulation models is necessary. Please send curriculum vitae and names of three references to: Professor Ronald G. Prinn, c/o Vera Ballard, MIT, E19–288, Cambridge, MA 02139.

MIT is an equal opportunity/affirmative action employer.

Geophysicist/University of Saskatchewan. Subject to final budgetary approval, the Department of Geological Sciences will have a new tenurable position in geophysics available July 1, 1984. Applicants should hold, or be about to receive, the Ph.D. or equivalent degree. They will be expected to teach undergraduate and graduate courses in geophysics and to build and maintain a vigorous research program. Excellent research opportunities exist in crustal and exploration seismology and in all fields of mining geophysics. The department, to occupy a new building in 1986, already has well-equipped geophysical and data-processing facilities. Applicants should send a letter outlining their teaching and research goals, accompanied by a full curriculum vitae including the names of at least three referees, to Dr. W. G. E. Caldwell, Head, Department of Geological Sciences, University of Saskatchewan, Saskatoon, Canada S7N 0W0.

Chairman—Department of Geological Sciences, Wright State University. The Department of Geological Sciences, invites applications for the position of chairman, to be appointed September 1984. We seek a dynamic individual with administrative talents and an appreciation for research and practice-related educational activities. Rank is at the full professor level and no restrictions have been placed on areas of specialization. The department is active with 12 faculty and an emphasis on professional practice yet maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:

Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435.

Wright State University is an affirmative action/equal opportunity employer. Closing date for the position is October 31, 1983.

Atmospheric Science/SUNY-Albany. Tenure track position is available at Atmospheric Sciences Research Center. The staff member is required to conduct research on alternate energy sources, climatology, computer modeling and air quality. The successful candidate is expected to develop research proposals and engage in cooperative research with other staff and state-federal organizations.

Ph.D. required and capability in two or three languages would be most helpful. Send resume to:

Dr. Raymond A. Castillo
ASRC—ES 324
State University of New York at Albany
1400 Washington Avenue
Albany, New York 12222

An Equal Opportunity Employer.

Chief, Ocean Requirements and Data Analysis Division. The National Oceanic and Atmospheric Administration (NOAA) announces Senior Executive Service Vacancy for Chief, Ocean Requirements and Data Analysis Division, National Ocean Service, location in Rockville, Maryland. Duties include providing scientific and technical leadership in the management, development, and execution of major programs in oceanography and related sciences. Pay rate for this SES position commensurate with background and experience: current salary range $56,945—$67,200 per annum. Apply to NOAA/NOS, 6001 Executive Boulevard, Rockville, Maryland 20852, Attention: AT/PER15GMT Personal Qualifications Statement (SF 171), must be received by August 19, 1983 to be considered.

Equal Opportunity Employer.

University of Colorado, Boulder, Geochemist Position. Geochemist with active research program, stable isotopes, radioactive isotopes, and/or trace elements is being sought for a joint appointment in the Department of Geological Sciences and the Cooperative Institute for Research in Environmental Sciences (CIRES) of the University of Colorado.

The one-half time position within the Department of Geological Sciences is tenure track at the assistant or associate professor level with a starting salary of $12,000—$15,000 for the academic year.

Teaching load will be half that of full-time faculty. The position within CIRES will be as a Fellow with appropriate office and laboratory space. One-half academic year salary will be guaranteed by CIRES for two years at the departmental rate, after which incumbent must generate his/her CIRES salary from external sources. Incumbent may augment salary further by generating three months of summer salary from contracts and grants, and consulting.

Applicants with experience, publications, and/or movable existing research equipment preferred. Preferred starting date would be January 1, 1984. Closing date for applications is October 1, 1983.

Applications should include statement of research and teaching interests, experience, a full vitae, and four letters of reference.

Apply to: Professor Charles Stern, Chairman, Geochemist Search Committee, Department of Geological Sciences, Campus Box 250, University of Colorado, Boulder, CO 80309.

The University of Colorado is an equal opportunity/affirmative action, Section 504 employer.

Université du Québec, Rimouski/Faculty Position in Geological Oceanography. The Université du Québec à Rimouski seeks qualified persons to fill the following position: Full-time professor of geological oceanography.

FUNCTIONS: The successful candidate will be required to teach courses at the undergraduate and graduate levels and to develop new courses in subjects such as mineralogy, stratigraphy and micropaleontology, and will be expected to collaborate with existing research programs in the fields of benthic-boundary layer, biogeochemistry and coastal sediment dynamics.

REQUIREMENTS: The successful candidate must possess the doctorate in geological oceanography or marine geology with specialization in mineralogy and/or micropaleontology, and direction research involving Quaternary marine deposits. Courses are given in French.

All applications will be treated confidentially. (Canadian law requires that Canadian citizens or landed immigrants be given preference). Interested persons should send their curriculum vitae before August 15, 1983 to:

Directeur
Département d'océanographie
Université du Québec à Rimouski
300, avenue des Ursulines
Rimouski, QC G5L 3A1.

Seismologist, Geophysicist/Carnegie Institution of Washington. A post doctoral position has just become available at the Department of Terrestrial Magnetism for a seismologist/geophysicist with broad interests. Please mail resume and request three letters of reference to be sent to Geophysics Fellowship Committee, Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road NW, Washington, D.C. 20015.

Postdoctoral Position/Naval Postgraduate School. The Ocean Turbulence Laboratory has available a postdoctoral position for a person interesed in the analysis and interpretation of oceanic turbulence data. The tenure is for one to two years. The successful candidate should have a Ph.D. in physical oceanography and although experience with turbulence data is preferable it is not essential. The opportunity for involvement in data gathering expeditions is also available.

Resumes can be sent to Dr. R.G. Lueck, Code 68Ly, Naval Postgraduate School, Monterey, CA 93940.

An Equal Opportunity/Affirmative Action Employer.

Research Scientist/Space Plasma Physics, University of Iowa. A research position is available in the Department of Physics and Astronomy, The University of Iowa, for theoretical and interpretative studies of waves in space plasmas. Specific emphasis is on theoretical investigations of wave-particle interactions in planetary magnetospheres and in the solar wind. These investigations are to support the interpretation of data being obtained from spacecraft projects such as Dynamics Explorer, International Sun Earth Explorer and Voyager. The applicant must have a Ph.D. with good qualifications in plasma physics theory and shoud have some experience in the interpretation of space plasma physics data.

Send a resume and the names of three references familiar with the applicant's work to: D.A. Gurnett, Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242, telephone 319-353-3527.

The University of Iowa is an affirmative action/equal opportunity employer.

University of Nevada/Seismological Laboratory. An immediate postdoctoral fellowship is available for research on seismic and volcanic hazards in the southern Sierra Nevada of California and Nevada. Emphasis will be on studies of earthquake distribution and mechanisms in the area of interest, configuration of the Long Valley magma chamber, and development of advanced software tools for anaysis of data from a network of analog and digital seismic stations. A Ph.D. degree, earned for work in seismology, is required, as is experience in network seismology. The appointment will be for one year, renewable for one year. Send resume to Alan Ryall, Seismological Laboratory, University of Nevada, Reno, NV 89557–0018.

The University of Nevada ia an affirmative action/equal opportunity employer.

Atmospheric Scientist/Arecibo Observatory. The National Astronomy and Ionosphere Center has a staff position available in the atmospheric sciences groups at the Arecibo Observatory in Puerto Rico. It is expected that this will be a long term appointment with the level depending on experience and qualifications. Applicants should have a doctoral degree and a demonstrated ability to pursue an independent research program in the atmospheric sciences. Interest and experience in the remote sensing via radar of the ionosphere or lower atmosphere or in the field of Ionospheric Modification is highly desirable.

The successful applicant will have full access to the facilities of NAIC. For atmospheric research these include the high powered 430 MHz incoherent scatter radar, a bistatic 2380 MHz radar for stratospheric studies, airglow instrumentation and a H.F. Ionospheric Modification facility. A 50 MHz radar intended for MST studies will be available shortly. Scientific staff members at Arecibo have most of their time force to pursue their own research. They are also expected to provide assistance to visiting scientists and support for the Observatory's operation.

Applications including a resume and names for three references should be sent to:

Dr. Tor Hagfors, Director
National Astronomy and Ionosphere Center
Cornell University
Ithaca, New York 14853

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Chief, Ocean Services Division. The National Oceanic and Atmospheric Administration (NOAA) announces Senior Executive Service Vacancy for Chief, Ocean Services Division, Office of Oceanography and Marine Services, National Ocean Service, located in Rockville, Maryland. Duties include providing scientific and technical leadership in the management, development, and execution of major programs in oceanography and related disciplines. Pay rate for this SES position commensurate with background and experience; current salary range $56,945—$67,200 per annum. Apply to NOAA/NOS, 6001 Executive Boulevard, Rockville, Maryland 20852. Attention: AT/PER15DH. Standard Form 171—Personal Qualifications Statement must be received by August 19, 1983, to be considered.

Equal Opportunity Employer.

Seismologist. The Institute for Petroleum Research and Geophysics in Holon, Israel, is seeking a seismologist to work on problems of earthquake risk assessment. Employment is for a period of one year with possible extension. Experience in statistical evaluation of earthquake risk is preferable but not mandatory. The Institute is a government owned company located in a suburb of Tel Aviv. It is responsible for most of the geophysical work in Israel and it has an active seismological program including countrywide and local telemetered seismic networks.

Benefits include relocation expenses, housing allowance and a car. For details contact Dr. A. Shapira, Head, Seismological division, The Institute for Petroleum Research and Geophysics, P.O. Box 1717, Holon 58117, Israel, telephone 03–805112

AGU

1983 Maurice Ewing Medal

Fred Noel Spiess

Citation

The Maurice Ewing Medal is presented jointly by the U.S. Navy and AGU for significant contributions to one or more of the following areas: the understanding of physical, geophysical, and geological processes in the ocean; significant original contributions to scientific ocean engineering, technology, and instrumentation; and outstanding service to marine sciences. Fred Noel Spiess has done all of these things superlatively.

If one is to work successfully in the oceans, it is useful (although not strictly necessary) to enjoy being at sea—Samuel Johnson, Charles Darwin and Lord Nelson notwithstanding. Fred Spiess combines this enjoyment of seagoing with a logical nature that leads him to the physical heart of a problem, an inventiveness that makes it natural to develop the tools that he needs when they don't exist, an ability to work well with others in a wide variety of disciplines, and leadership that persuades others to work on significant problems.

Fred's involvement with the ocean and the Navy began with Naval ROTC membership at the University of California, Berkeley, as an undergraduate. His postgraduation training cruise in 1941 quickly turned into wartime submarine service; during that time he engaged in 13 war patrols. Graduate study at UC Berkeley after World War II in high-energy physics didn't keep him away from the ocean long; it did teach him (as it taught others in that energetic group) to be his own instrument maker, plumber, inventor, and scrounger of surplus—skills that have served him well.

He joined the Marine Physical Laboratory (MPL) of the Scripps Institution of Oceanography in 1952 and promptly fitted into MPL's program of research into "the generation, propagation, and detection of energy in the ocean and surrounding media." His initial work at MPL was in studies of fluctuation and coherence of underwater sound. This has expanded over the years into the uses and limitations of underwater sound for detection, communications, navigation, and mapping, and in ways to overcome some of those limitations.

In the course of carrying out studies of sound propagation in the ocean he found a need for a stable platform from which to measure the variability of the angle of arrival of sound rays. Basing his work on a suggestion from Allyn Vine, and working in collaboration with Frederick H. Fisher, Philip Rudnick, Lawrence M. Glosten, and others, he developed a device that looks very much like a submarine standing on one end: the Floating Instrument Platform (FLIP). Designed and built originally for a single experiment, FLIP has instead become one of the basic tools of acoustic research, and is still going strong after 21 years.

Another tool devised by Fred, originally to measure the distribution of slope angles and map the fine-scale topography of the sea floor was the "Deep Tow" fish. It has found much broader application in the solutions of a wide variety of problems. Initially an echo sounder towed near the bottom, it is now a device to make nearly any kind of measurement one might want to make in the deep sea; a device to convert deep-water problems into shallow-water problems to evade the $1/r$ or $1/r^2$ smoothing of geophysical fields and thereby make them more tractable. While finding new and productive uses for the Deep Tow, Fred has become involved in geophysics, geology, physical and chemical oceanography, geodetics, archeology, and even marine biology in the studies of the hydrothermal vents at oceanic spreading centers. In all of these areas he has worked with a diverse group of scientists, adding significantly to their work and not just providng a vehicle for their measurements.

The Navy and the National Academy of Sciences long ago recognized his ability to turn big problems into little ones by appointing him to the Naval Research Advisory Committee, the Ocean Sciences Board, and a host of other committees. In his various roles of leadership at the Marine Physical Laboratory of Scripps, at the Scripps Institution itself, more recently at the University of California Institute of Marine Resources, and as the chief scientist on innumerable oceanographic cruises, Fred Spiess has shown his ability to inspire others to carry out significant research in oceanography and geophysics. At the same time he has earned the trust, confidence, and respect of all who work with him.

It is for his contributions to the study of underwater sound and geophysics; for the development of a wide variety of tools that have enabled others to study the biology, geology, geophysics, and physics of the ocean and "surrounding media"; and for his selfless leadership in many ways that has encouraged others to work on problems of importance to our science and to the Navy that Fred Spiess is awarded the Maurice Ewing Medal.

George G. Shor, Jr.

Acceptance

President Van Allen, George Shor, friends of AGU, thank you very much for your introduction and your very generous citation. I was incredulous when I received word of this award. However, as I thought of the Office of Naval Research's co-sponsorship and my own long-term association with the Navy, I became somewhat more comfortable about accepting it. The occasion provides a good opportunity to acknowledge and commend the Navy's continuity of research support, which has been a key element in our seagoing ventures as for those of many others.

Maurice Ewing, in common with the other oceanographic giants of his day, has directly or indirectly left his mark on all of us. Unfortunately for me, he was a distant and shadowy figure, and thus I am in no position to embellish my remarks with personal remembrances. The challenges that he presented, however, provided part of the motivation for our activities.

Unlike most of my predecessors in the chain of Ewing medalists, I cannot even hark back to graduate days in the formative years of oceanography and geophysics. As a product of the Berkeley physics department, my undergraduate and graduate exposures were to the intense, innovative, self-confident, laboratory world of experimental physics of the 1930s and 1940s, under the influence of many who have become Nobel Laureates. I particularly note Emilio Segrè, with whom I did my thesis work.

This landlocked laboratory life was interrupted, however, by four wartime years as a submarine officer. The ocean was very close: I learned about internal waves by struggling to maintain periscope depth and about surface waves by being battered by them while on watch in Pacific storms. This was the real world of depth charges and of complex machinery to be used effectively, usually far from the nearest friendly base or ship. It bred an overriding respect for teamwork and the self-sufficiency of small groups, which are the essentials of effective seagoing research.

Oceanography started for me in 1952 when Carl Eckart and Roger Revelle asked me to join the Marine Physical Laboratory at Scripps Institution of Oceanography. Suddenly, I was able to merge the two worlds in which I had been raised. The result has been an exciting, stimulating 30 years that, in spite of occasional moments of frustration, or even defeat, I would not trade for any other life.

The award's citation, of which George Shor, my friend of many years, was the principal author, leans particularly on the technological achievements in which I have been involved and on what he calls my "quiet leadership." I would like to say a little about each of these.

I enjoy competing with the ocean for knowledge of its secrets. In the pattern of good experimental physicists this means enjoyment of conceiving, building, and actually using new machinery to score occasional victories in this continuing campaign. I have been particularly lucky, however, in my timing. In the 1950s and 1960s, research administrators were willing to gamble heavily on ideas generated by those of us out in the field. The results were many new devices: *Flip, Alvin, Deep Tow, Dimus*, underwater communication systems, magnetometers, and many others, as well as new ideas. It seems to me, however, that in more recent times a conservatism has set in that has reduced the fraction of our research effort that involves

AGU *(cont. on p. 478)*

AGU *(cont. from p. 477)*

appreciable risk. This is unfortunate and, if it continues much longer, it will lead to stagnation. We already see the beginning of this as National Science Foundation (NSF) oceanography fails to keep up with other fields in recent budget growth. I hope our major advisory groups and those of you who work in the Washington scene will be able to reverse this trend.

With regard to leadership, this is largely a matter of associating oneself with very good people. The fact that this award recognizes leadership implies strongly that it also recognizes the achievements of many people rather than simply those of the recipient. In my case there are thus four groups, plus one individual, who all share my honor. Scripps itself is one, for its facilities, but even more for the people who gather there and have stimulated and enriched my life. Within that is the Marine Physical Laboratory, which has been my home base for over 30 years and of which I was privileged to be Director for 22 years. It maintains a challenging environment in which my colleagues tend to think of research problems in terms of ambitious, usually large, and even preposterous devices, most of which eventually work effectively. Then there is my own research group in which I have been particularly fortunate in being associated with a succession of supportive and competent physicists and engineers—Maurice McGehee, Bill Whitney, Tony Boegeman, John Mudie, and Carl Lowenstein—willing and able to build something new on short notice whether on shore or at sea.

The fourth group is one in which I take great pride, the 23 students, with more on the way, who have received their Ph.D's under my chairmanship or by using technology developed and operated by my group. Following my own convictions about the importance of interdisciplinary activity in ocean science, these include geologists, geophysicists, physical oceanographers, marine biologists, and engineers. I want to thank them for their patience in educating me on a variety of topics while finding their ways through the transition from undergraduate student to mature scientist.

Finally, this award recognizes my wife who, for over 40 years, has put up first with a young naval officer's wartime search for danger and then many more years of oceanographic expeditions, including one starting 2 days from now. She has been tolerant and supportive as she has raised our family and made her own contributions to the local community.

Realizing that this medal recognizes all of these people and their achievements provides a logical rationale for its award and on that basis I am most pleased to be given the opportunity to accept it.

Thank you all.

Fred Noel Spiess

Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation; the letter A denotes the Atmospheric Sciences section, which was formerly the Meteorology section.

Regular Member

Keith F. Carney (T), Charles W. Challstrom (G), Ruthann Corwin (O), Peter K. Davies (V), G. Nelson Eby (V), Henri E. Gaudette (V), Robert G. Gregory (H), Hendrik M. Haitjema (H), Norman Hubbard (H), George W. Lee (H), Roger M. Lhermitte (A), Ke Ren Liu (S), Polly A. Penhale (O), A.C. Powell (T), Ruth H. Preller (O), Edward J. Rogers (T), John L. Rogers (P), Sedgwick Simons (A), Douglas J. Trieste (H), James A. Wilcoxon (O), Adele Fuller Williams (P).

Student Member

J.G. Andersen (S), Christopher Basnett (O), Carl Raphael Baum (P), S.L. Brantley (V), Cheryl Brower (O), Steven L. Cartier, Seogyeon Cho (A), Peter Crowley (T), Ruth Dickinson (H), Reda M. El-Damak (H), Ismail I. El-Hemry (H), Bradley Gene Erskine (GP), Benjamin Frisch, Iris M. Lutz, Batakrishna Mandal (S), Eric H. Mohring (H), Charles A. Rine (S), Tim P. Roche (S), Christine M. Sperber (S), Sudjarwadi (H), Jorge Vazquez (O), John L. Wilkin (O), Chris Zervas.

Associate Member

Paul R. Belyea (O), Carol A. Seitz (S), Michael S. Stanton (T).

Meetings

Announcements

Atmospheric Electricity

For the first time in 25 years the International Conference on Atmospheric Electricity will be held in the United States. Organized by the Atmospheric Science Group at the State University of New York at Albany, the gathering will take place June 4–8, 1984.

This seventh conference in the series will serve as the forum for papers on such topics as fair weather electricity, the physics and chemistry of lightning, triggered lightning experiments, satellite observations of lightning on the earth and other planets, and the interactions between electrical processes in the upper atmosphere and in the troposphere.

Authors interested in presenting papers at the conference should submit abstracts of not more than 300 words by November 1, 1983, to Atmospheric Electricity Conference, E.S. 214, 1400 Washington Ave., SUNYA, Albany, NY 12222. For more information contact Richard E. Orville (telephone: 518-457-3987).

Cosponsors of the conference are the International Commission on Atmospheric Electricity, a commission of the International Association of Meteorology and Atmospheric Physics, and the American Meteorological Society.

Transport in Groundwater

The AGU Groundwater Committee is sponsoring a special session at the 1984 AGU Spring Meeting that will focus on miscible and immiscible transport of chemicals in porous media. The Spring Meeting will be held in Cincinnati, Ohio, May 14–18, 1984.

Highlighting the session are such topics as conceptual models of transport processes and their mathematical description, the applicability of theory to field problems, and the reliability of predictions. Discussions may deal with progress made in understanding dispersion and attenuation mechanisms over the course of the past 10 years and with recent developments in characterizing multifluid flow at hazardous waste sites. As part of the program a panel discussion on dispersion will be held. A related symposium, held concurrently, will focus on field measurements of parameters affecting transport.

Authors interested in contributing papers should submit an abstract in AGU format by February 6, 1984, to James W. Mercer, GeoTrans, Inc., P.O. Box 2550, Reston, VA 22090 (telephone: 703-435-4400) or Leonard Konikow, U.S. Geological Survey, 431 National Center, Reston, VA 22092 (telephone: 703-860-6892). One original and two copies of the abstract must also be sent to AGU Meetings, 2000 Florida Ave., N.W., Washington, D. C. 20009, by February 22.

Irrigation Show

The Second Annual Western Irrigation Show will be held October 18–20, 1983, at the International Agri-Center in Tulare, Calif. More than 150 exhibitors will be present, and daily seminars will highlight the latest technology in irrigation. Computer applications in irrigation will be the subject of special sessions.

For more information contact Diane G. Thompson, Aikins, Marling, and Morris, Inc., 276 Main Street, San Francisco, CA 94105 (telephone: 415-543-1123).

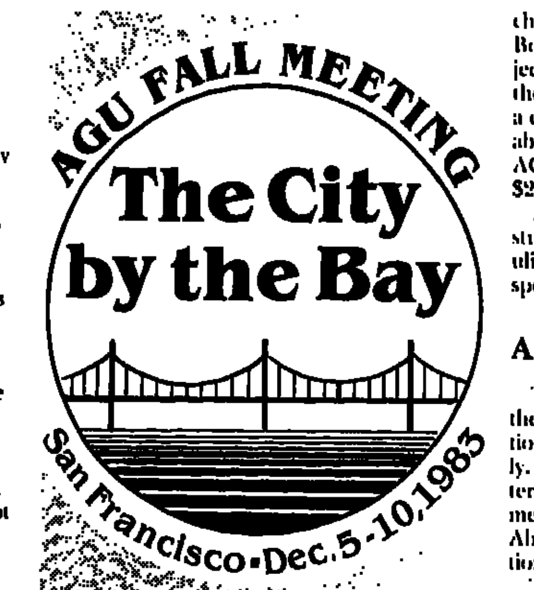
British Science

The British Association for the Advancement of Science will hold its annual meeting August 22–26, 1983, at the University of Sussex in Brighton.

Among the myriad topics to be presented are new telescopes for British astronomers; British earthquakes; the Infrared Astronomy Satellite (IRAS); volcanoes and climatic change; X ray astronomy; deep crust; Halley's comet mission and space technology; seismology and the deep continental crust; satellites, gravity, and geology; oil exploration in southern England; the Space Telescope; the break-up of Gondwanaland; the extinction of the dinosaurs; the Wealden rocks of southeast England; and geothermal heat.

In addition, the Mason Conferences will feature presentations on the applications of synchrotron radiation; the global INTELSAT system; earth resources satellites; user needs of meteorological services; the water industry and planning for the weather; meteorological forecasting for the public; climatological services; dust in the early solar system; meteorites; and ocean science.

For additional information, contact the British Association for the Advancement of Science, 23 Savile Row, London W1X 1AB, U.K.



Abstract Deadline: September 14

Call for Papers

Abstracts must be received at the AGU office by 5:00 P.M. on September 14 to be on time. Late abstracts (1) may be summarily rejected by program chairman, (2) may not be published in advance of the meeting, and (3), if accepted, will be charged a $25 late fee in addition to the regular publication charge.

The 1983 Fall Meeting of the American Geophysical Union will be held in San Francisco December 5–10 at the Cathedral Hill and Holiday Inn/Golden Gateway hotels. Blocks of rooms are being held at the Cathedral Hill, the Holiday Inn/Golden Gateway, the San Franciscan, the Holiday Inn/Civic Center, and the Grosvenor Inn for those attending. Corresponding authors will be sent housing and registration forms. In addition, the forms will be published in *Eos*.

General Regulations

Abstracts may be rejected without consideration of their content if they are not received by the deadline or are not in the proper format. Abstracts may also be rejected if they contain material outside the scope of AGU activities or if they contain material already published or presented elsewhere. **Only one contributed paper by the same first author will be considered for presentation;** additional papers (unless invited) will be rejected automatically.

Only AGU members may submit an abstract. The abstract of a nonmember must be accompanied by a membership application form (with payment) or it must be sponsored by an AGU member.

There is a publication charge of $40 ($30 if prepaid) for each abstract. The publication charge is $20 if the first author is a student. Both invited and contributed papers are subject to the publication charge. Prepayment of the publication charge can save money. Send a check for $30 ($15 for students) with your abstract. The abstract must be received at AGU by September 14 to avoid an additional $25 charge.

AGU will acknowledge receipt of all abstracts. Notification of acceptance and scheduling information will be mailed to corresponding authors in late October.

Abstracts

The abstract page is divided into two parts: the abstract itself and the submittal information. Follow the instructions for both carefully. Please use a carbon ribbon to type the material, and do not exceed the maximum dimensions (11.8 cm x 18 cm) of the abstract. Abstracts that exceed the noted size limitations will be trimmed to conform.

The meeting program will be prepared by photographing the abstracts exactly as they are received. Use the model abstract to prepare the final version. Submission of an abstract for an AGU meeting is presumed to carry with it permission for AGU to reproduce the abstract in all editions of *Eos* and in the programs and reports relating to the meeting. It is also presumed to permit the free copying of those abstracts. Although *Eos* is a copyrighted journal, authors are not requested to transfer copyright. Copyright, where it exists, will be reserved by the authors.

Submittal Information

Numbers refer to the items in the submittal block on the sample abstract.

1. Title of meeting.
2. Identification (only members may submit an abstract; this includes invited authors). Type the identification number of one member author (ID number is the line consisting of four letters followed by the six digits; see member's mailing label on *Eos* or journals), or if no author is an AGU member, type the ID number of the member sponsor (sponsor's name must also appear on the abstract at the end of the author portion). If no ID number is given, a membership application and dues payment must accompany the abstract. Call AGU immediately if you need an application (800-424-2488 toll free or 462-6903 if you are in the Washington, D.C. area).
3. Corresponding address: Give complete address and phone number of author to whom all correspondence (acknowledgment and acceptance letters) should be sent. Abbreviate as much as possible.
4. Section of AGU to which abstract is submitted (use the following letter abbreviations): A (Atmospheric Sciences); G (Geodesy); GP (Geomagnetism and Paleomagnetism); H (Hydrology); O (Ocean Sciences); P (Planetology); S (Seismology); SA (Aeronomy); SM (Magnetospheric Physics); SC (Cosmic Rays); SS (Solar and Interplanetary Physics); T (Tectonophysics); V (Volcanology, Geochemistry, and Petrology); U (Union).
5. Type title of special session (if any) to which submittal is made.
6. Indicate your preference for a particular kind of presentation by one of the following letters: O, oral; P, poster. The chairman may assign you to either of these types of presentation in order to fit his program plan.
7. Percent of material previously presented or published, and where.
8. Billing information.

(*a*) Complete billing address if other than the corresponding address (item 3 above).

(*b*) If purchase order is to be issued, indicate number upon submittal of abstract. Invoices returned to AGU because of insufficient billing information will be assessed an additional charge of $10.

(*c*) If a student member is the first author, the student publication rate is applicable. Type "student rate applicable."

(*d*) If prepaid, enter amount enclosed.

9. Indicate whether paper is C (contributed) or I (invited). If invited, list name of inviter.

For actual size, see *Eos*, June 28, 1983, p. 433.

Sample Abstract

11.8 cm

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Technique for the Preparation of Abstracts

F. R. S. T. AUTHOR (School of Oceanography,
  Hydro University, Watertown, Mass.  02172)
S. C. N. D. AUTHOR (USGS, Woods Hole, Mass. 02543)
  (Sponsor:  I. C. Alvin)

  Follow this example in typing the abstract.  The
printing plates will be prepared by photographing
the abstracts exactly as they are received, except
that abstracts exceeding the maximum length (18 cm)
or width (11.8 cm) will be cut to conform.
  Use a good typewriter with a ribbon in good
condition.  A carbon ribbon gives the best results.
Please use type of about this size.  Use 12 pitch.
There will be a reduction of 50% for the printed
abstract volume.

 Follow these guidelines:
 (1) Type title in capital and lower case letters
     except where all capitals are standard.
     Underscore entire title.
 (2) Leave one line blank after title.
 (3) Type names of authors in all capital
     letters, with affiliation and address in
     capital and lower case letters.  Do not leave
     blank lines between authors.
 (4) Underscore the name of author who will
     present paper.
 (5) If no author is an AGU member, type sponsor's
     name in capital and lower case letters.
 (6) Leave one blank line after author block.
 (7) Neatly drawn in symbols or Greek letters are
     acceptable.  Use India ink.
 (8) Use SI units.
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18 cm

NOTE: There are no special forms distributed for typing abstracts. You may trace this form in nonreproducible ink. Please leave at least 4 cm between top edge of paper and abstract title. Type abstract as close as possible to left edge of paper.

Submittal Information

(See explanation)

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1.  Fall Meeting
2.  AUTH052536
    or
    ALVI012346 (Sponsor)
3.  (a). Corresponding address:
    S.C.N.D. Author
    MS 123
    USGS
    Woods Hole, MA  02543
    (b). Telephone number
         617-548-1234
4.  O (Ocean Sciences)
5.  Special Session:
      HEBBLE
      (or none)
6.  P (Poster)
7.  10% at Midwest Meeting
8.  (a). Hydro Univ.
         Accounting Dept.
         Admin. Bldg.
         Watertown, MA  02172
    (b). P.O. #5684739
    (c). Student rate applicable
    (d). If prepaid enter amount
         enclosed. (P.O.'s required
         invoicing are not eligible
         for discount rate)
9.  C (Contributed)
```

Abstract Deadline: September 14

Mail original and two copies to Fall Meeting

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Poster Sessions

A large, centrally located meeting room will be set up for poster presentations. Experience from recent AGU meetings and from other scientific societies has shown that a poster presentation, while more demanding of the author, can provide a superb opportunity for comprehensive discussions of research results. Some sections are organizing poster sessions on specific topics, and contributed papers on these subjects will automatically be scheduled as posters. In other sections it may be necessary to assign papers to poster sessions even though their authors requested oral presentation.

Presenters of poster papers are reminded that a poster exhibit requires careful preparation. Figures and text will be scrutinized in detail, and authors must be prepared to discuss the contents of their papers in depth. Under these conditions, well-prepared figures and concise, logical text are essential.

Program Committee

Meeting Chairman H. Frank Eden, NSF
Atmospheric Sciences (A) Ronald Taylor, NSF
Geodesy (G) William Sjogren, Jet Propulsion Laboratory
Geomagnetism and Paleomagnetism (GP) Subir K. Banerjee, University of Minnesota
Hydrology (H) Dennis P. Lettenmaier, University of Washington, Seattle
Ocean Sciences (O) Dave Cutchin, Scripps Institution of Oceanography
Planetology (P) Richard J. Terrile, Jet Propulsion Laboratory
Seismology (S) Robert J. Geller, Stanford University
SPR: Aeronomy (SA) Raymond G. Roble, NCAR
SPR: Cosmic Rays and Solar and Interplanetary Physics (SC/SS) Miriam A. Forman, SUNY, Stony Brook (*SC*); Bruce T. Tsurutani, Jet Propulsion Laboratory (*SS*)
SPR: Magnetospheric Physics (SM) Michael Schulz, Aerospace Corp.
Tectonophysics (T) Raymond F. Jeanloz, University of California, Berkeley
Volcanology, Geochemistry, and Petrology (V) Peter W. Lipman, USGS

Special Sessions

* Indicates new special sessions.

Union

*Orinoco and Amazon Rivers: An Overview
Research in the Polar Regions

Geomagnetism and Paleomagnetism (GP)

Applications of Paleomagnetism to Tectonics of the Western United States
Electrical Conductivity of the Crust and Upper Mantle—Field Methods and Laboratory Measurements (in cooperation with *T* and the Committee on Mineral Physics)
Problem Solving With Rock Magnetic Techniques—Workshop

Hydrology (H)

Glacier–Ocean Interactions (cosponsored by *O*)
Instream Flow Requirements for Fish: Methodologies, Implementation and Impacts
Multivariate Modeling of Hydrologic and Other Geophysical Time Series
Orinoco and Amazon—Hydrology, Sedimentology, Geochemistry, and Ecology of Large Tropical Rivers
Searching for More Physically Based Extreme Value Distribution in Hydrology
Statistical Procedures for Estimation of Flood Risk at Gauged Sites
Symposium on Optimization Techniques for Managing Groundwater and Stream–Aquifer Systems
*Transport and Geochemical Interactions in Stream Water
Transport Processes of Excessive Sediment Loads
Treatment of Evapotranspiration, Soil Moisture Evolution, and Aquifer Recharge in Watershed Models
Water Quality Analysis of Impoundments

Ocean Sciences (O)

California Current
Chemical Tracers and Global Circulation Modeling
Diagenesis in Deep Sea Drilling Cores
El Niño of 1982–1983
Geochemistry of Estuaries
Geochemistry of Hydrothermal Plumes in Vicinity of Mid-Ocean Ridges
HEBBLE
MANOP
Ocean–Glacier Interactions (cosponsored by *H*)
*Oceanographic and Geodetic Research With Altimetry Measurements (cosponsored by *G*)
Response of the Upper Ocean to Very Strong Wind
Rossby Waves and Eddies in the Eastern Parts of Ocean Basins
Sedimentation Patterns in Tectonics in Active Continental Margins (cosponsored by *T*)
Sub-Seabed Disposal of Nuclear Wastes: Site Assessment

Seismology (S)

Evolution of Oceanic Lithosphere (cosponsored by *T* and *VGP*)
Rio Grande Rift (cosponsored by *T* and *VGP*)
Lateral Heterogenesis in the Mantle
Deep Earth Tomography

SPR: Aeronomy (SA)

EUV-UV Airglow
Lower Thermosphere–Upper Mesosphere

SPR: Cosmic Rays (SC)

IMP 7 & 8: Correlative Studies Over the Solar Cycle, Including Correlative Studies With Other Spacecraft and/or With Ground Data (poster session) (cosponsored by *SM* and *SS*)
IMP 7 & 8: Other Results (submit to appropriate topical session in SC, SM, or SS, as appropriate) (cosponsored by *SM* and *SS*)

SPR: Magnetospheric Physics (SM)

Aurora and Substorms (poster session)
Comparative Planetary Magnetospheres and Comparative Auroral Phenomena
*Geomagnetic Pulsations
Geomagnetic Tail and Boundary Layer (poster session)
Magnetospheric Currents and Fields (poster session)
Numerical Simulation of Space Plasmas (poster session)
Special Call for Papers on All Subjects
Waves, Instabilities, and Turbulence in Space Plasmas (poster session)

SPR: Solar and Interplanetary Physics (SS)

AMPTE Theory and Predictions
Solar Wind Interactions With Comets, Venus and Titan (cosponsored by *P* and *SC*)

Tectonophysics (T)

Active Tectonics—Impact on Society
Franciscan Geology of the San Francisco Bay Area: The Nanoplate Tectonics of the AGU Fall Meeting Site
Tectonics and Sedimentation in Active Continental Margins (cosponsored by *O*)

Volcanology, Geochemistry, and Petrology (V)

Calderas and Associated Volcanic Rocks (Krakatau Centennial)
Cascades Volcanism and Implications for Geothermal Resources
Ocean-Ridge Basaltic Volcanism (Laki Bicentenial)
Structure and Dynamics of Hawaiian Volcanoes

Other Special Sessions

Mineral Physics

If your paper covers one of the following fields in the broadest sense, regardless of the section to which your paper is submitted, please add on your abstract, under number 5 of the submittal information, the phrase "For Mineral Physics Session" and one of the following fields: (1) physical measurements on minerals, (2) calorimetry, (3) high-pressure mineralogy, (4) defect structure studies, (5) mineral and solids equation of state, (6) quantum mechanics of solids, (7) spectral mineralogy, or (8) electrical measurements on minerals.

Session Highlights

The following descriptions were received after publication of the June 28, 1983, issue of *Eos*, which contains descriptions of other special sessions.

Research in the Polar Regions (U)

Scheduled for Thursday A.M., December 8, this session will discuss current research in both polar regions with some emphasis on the Antarctic. Additionally, international plans for research, the activities of the Scientific Committee for Antarctic Research (SCAR), and the political environment of the regions will be reviewed. The session consists of six half-hour talks by distinguished speakers.

Transport and Geochemical Interactions in Stream Water (H)

This symposium offers an interdisciplinary forum for hydrologists and geochemists to discuss the coupled mechanisms influencing water quality. It will emphasize research directed toward quantifying interactions of hydrologic process and chemical reaction in stream. Among the topics of interest are (1) development of transport simulation which includes steciation, sediment interaction, or precipitation/dissolution submodels; and (2) evaluation of associated field parameter uncertainties. Contributions focusing on current problem areas (for example, alterations in stream chemistry as an impact of acid rain or acid mine drainage) are also of interest. Abstracts, in standard AGU format, should be sent by August 31 to Kenneth E. Bencala, USGS, WRD, MS 96, 345 Middlefield Road, Menlo Park, CA 94025. In addition, send the original and two copies of the abstract to Fall Meeting, AGU, 2000 Florida Avenue, N.W., Washington, DC 20009.

Geophysical Year

The complete Geophysical Year last appeared in the May 31, 1983, *Eos*.

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

New Listings

Sep. 13–14, 1983 12th Annual Conference of the Illinois Department of Energy and Natural Resources on Illinois Climate: Trends, Impacts, and Issues, Urbana, Ill. (Mae Maxwell, Office of Conferences and Institutes, University of Illinois, Urbana, IL 61801; telephone: 217-333-2883.)

Jan. 11–14, 1984 National Meeting of the International Union of Radio Science (URSI), Boulder, Colo. Sponsor, U.S. National Committee of URSI. (T. E. VanZandt, NOAA/ERL, R/E/AL3, 325 Broadway, Boulder, CO 80303; telephone: 303-497-3854.)

June 4–8, 1984 Seventh International Conference on Atmospheric Electricity, Albany, N. Y. Sponsors, International Commission on Atmospheric Electricity (of IAMAP) and AMS. (Richard E. Orville, Atmospheric Electricity Conference, E.S. 214, 1400 Washington Ave., SUNYA, Albany, NY 12222; telephone: 518-457-3987.)

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Electromagnetics

0785 Tropospheric propagation
A RIGOROUS ANALYSIS FOR THE STUDY OF RAIN ATTENUATION AND DEPOLARIZATION STATISTICS FOR TERRESTRIAL AND EARTH-SPACE LINKS
J.D. Kanellopoulos (Electrical Engineering Department, National Technical University of Athens, Athens- 147, Greece)

A well known rigorous technique proposed by Lin for predicting rain attenuation statistics for terrestrial links has been modified in order to apply to 5-min point rainfall long-term distributions and to include the case of earth-space links. This same technique leads to the construction of an effective predictive model for the rain depolarization statistics. Comparison of the so obtained theoretical results with experimental data has been quite encouraging. (Rain attenuation, depolarization).
Rad. Sci., Paper 3S0858

Geophysical Research Letters

Volume 10 Number 8 August 1983

Waves in Magnetospheric Plasmas
Waves in Magnetospheric Plasmas, Editorial (Paper 3L1142) *W. J. Hughes* 601
Electron Acceleration by Landau Resonance With Whistler Mode Wave Packets (Paper 3L0867) *D. A. Gurnett and L. A. Reinleitner* 603
Computer Simulation Studies of VLF Triggered Emissions Deformation of Distribution Function by Trapping and Detrapping (Paper 3L0873) *Hiroshi Matsumoto and Yoshiharu Omura* 607
Photometric Evidence of Electron Precipitation Induced by First Hop Whistlers (Paper 3L0879) *J. H. Doolittle and D. L. Carpenter* 611
The Modulated Precipitation of Radiation Belt Electrons by Controlled Signals From VLF Transmitters (Paper 3L0875) *W. L. Imhof, J. B. Reagan, H. D. Voss, E. E. Gaines, D. W. Datlowe, J. Mobilia, R. A. Helliwell, U. S. Inan, J. Katsufrakis, and R. G. Joiner* 615
Observations of VLF Transmitter-Induced Depletions of Inner Zone Electrons (Paper 3L0868) *A. L. Vampola* 619
Observations on GEOS-1 of Whistler Mode Turbulence Generated by a Ground-Based VLF Transmitter (Paper 3L0871) *T. Neubert, F. Lefeuvre, M. Parrot, and N. Cornilleau-Wehrlin* 623
Pc 1 Pearl-Electron Interactions on the L = 4.2 Magnetic Shell (Paper 3L0886) *R. L. Arnoldy, R. L. Kaufmann, L. J. Cahill, Jr., and S. B. Mende* 627
Electromagnetic Ion-Cyclotron Instability in the Multi-Ion Jovian Magnetosphere (Paper 3L0839) *Richard M. Thorne and Julie Moses* 631
Frequency Gap Formation in Electromagnetic Cyclotron Wave Distributions (Paper 3L0872) *B. H. Mauk* 635
Drift Boundaries and ULF Wave Generation Near Noon at Geostationary Orbit (Paper 3L0885) *A. Korth, G. Kremser, A. Roux, S. Perraut, J.-A. Sauvaud, J.-M. Bosqued, A. Pedersen, and B. Aparicio* 639
Generation of Alfven-Ion Cyclotron Waves on Auroral Field Lines in the Presence of Heavy Ions (Paper 3L1031) *Robert L. Lysak and Michael A. Temerin* 643
Apparent Electrostatic Ion Cyclotron Waves in the Diffuse Aurora (Paper 3L0869) *E. A. Bering* 647
The Mass Dependence of Wave Particle Interactions as Observed With the ISEE-1 Energetic Ion Mass Spectrometer (Paper 3L0870) *R. D. Sharp, W. Lennartsson, W. K. Peterson, and E. Ungstrup* 651
Magnetic Field Fluctuations in the Venus Magnetosheath (Paper 3L0874) *J. G. Luhmann, M. Tatrallyay, C. T. Russell, and D. Winterhalter* 655
Transfer of Pulsation-Related Wave Activity Across the Magnetopause: Observations of Corresponding Spectra by ISEE-1 and ISEE-2 (Paper 3L0877) *E. W. Greenstadt, M. M. Mellott, R. L. McPherron, C. T. Russell, H. J. Singer, and D. J. Knecht* 659
The Rate of Occurrence of Dayside Pc 3,4 Pulsations: The L-Value Dependence of the IMF Cone Angle Effect (Paper 3L0840) *C. T. Russell, J. G. Luhmann, T. J. Odera, and W. F. Stuart* 663
Plasma Drift Measurements With the Electron Beam Experiment on GEOS-2 During Long Period Pulsations on April 7, 1979 (Paper 3L1125) *H. Junginger, O. H. Bauer, G. Haerendel, F. Melzner, B. Higel, and E. Amata* 667
Remote Determination of the Outer Radial Limit of Stormtime Pc5 Wave Occurrence Using Geosynchronous Satellites (Paper 3L0881) *J. N. Barfield and C. S. Lin* 671
New Observations of Plasma Vortices and Insights Into Their Interpretation (Paper 3L0876) *E. W. Hones, Jr., J. Birn, S. J. Bame, and C. T. Russell* 674
Reflection of MHD-Waves in the Pc4-5 Period Range at Ionospheres With Non-Uniform Conductivity Distributions (Paper 3L0878) *Karl-Heinz Glaßmeier* 678
Experimental Modelling of Satellite Wakes in Auroral Arcs (Paper 3L0888) *N. Wild, R. L. Stenzel, and W. Gekelman* 682

Regular Issue
Crosshole Seismology and Seismic Imaging in Crystalline Rocks (Paper 3L0976) *J. Wong, P. Hurley, and G. F. West* 686
Geometry of Magma Bodies Beneath Long Valley, California Determined From Anomalous Earthquake Signals (Paper 3L0994) *Chris O. Sanders and Flori Ryall* 690
Local Earthquakes on Three-Component Seismographs: Heterogeneity in the Aftershock Zone of El Asnam, Algeria (10.10.1980, M = 7.3) (Paper 3L0917) *A. Nercessian, M. Sapin, A. Hirn, G. Wittlinger, and M. Djeddi* 693
Outer-Rise Earthquakes and Seismic Coupling (Paper 3L1144) *Douglas H. Christensen and Larry J. Ruff* 697
Determination of Timing of Volcanic Events by Secular Variation and Thermal Modeling (Paper 3L0918) *Kevin P. Furlong and Peter N. Shive* 701
The Mean Life of Continents: Estimates of Continent Recycling Rates From Nd and Hf Isotopic Data and Implications for Mantle Structure (Paper 3L0530) *Donald J. DePaolo* 705
Late Cretaceous Apparent Polar Wander of the Pacific Plate: Evidence for a Rapid Shift of the Pacific Hotspots With Respect to the Spin Axis (Paper 3L0459) *Richard G. Gordon* 709
Matching Long Term Periodicities of Geomagnetic Reversals and Galactic Motions of the Solar System (Paper 3L0201) *J. G. Negi and R. K. Tiwari* 713
Multi-Beam Doppler Sonar Observation of Tidal Flow Turbulence (Paper 3L0914) *Roger Lhermitte and Henry Poor* 717
Atmospheric Sodium Chemistry and Diurnal Variations: An Update (Paper 3L1136) *Volker W. J. H. Kirchhoff* 721
Acetonitrile in the Atmosphere (Paper 3L0729) *G. Brasseur, E. Arijs, A. De Rudder, D. Nevejans, and J. Ingels* 725
A Re-Evaluation of Laser Heterodyne Radiometer ClO Measurements (Paper 3L1013) *Robert T. Menzies* 729
Large Amplitude Middle Atmospheric Electric Fields: Fact or Fiction? (Paper 3L0998) *M. C. Kelley, C. L. Siefring, and R. F. Pfaff, Jr.* 733
Comparison of Spherical Double Probe Electric Field Measurements With Plasma Bulk Flows in Plasmas Having Densities Less Than 1 cm^{-3} (Paper 3L1124) *F. S. Mozer, E. W. Hones, Jr., and J. Birn* 737
Equatorial Ionospheric Currents Derived From MAGSAT Data (Paper 3L0709) *Manashi Ray* 741
Simulation of Auroral Current Sheet Equilibria and Associated V-Shaped Potential Structures (Paper 3L0997) *N. Singh, H. Thiemann, and R. W. Schunk* 745
A Statistical Study of the Dynamics of the Equatorward Boundary of the Diffuse Aurora in the Pre-Midnight Sector (Paper 3L1032) *J. A. Sauvaud, J. Crasnier, Yu. I. Galperin, and Y. I. Feldstein* 749
Upward Electron Beams Measured by De-1: A Primary Source of Dayside Region-1 Birkeland Currents (Paper 3L0882) *J. L. Burch, P. H. Reiff, and M. Sugiura* 753
Geos 2 Plasma Drift Velocity Measurements Associated With a Storm Time Pc5 Pulsation (Paper 3L1058) *A. D. M. Walker, H. Junginger, and O. H. Bauer* 757
Ring Coupling Model: Implications for Substorm Onsets (Paper 3L0971) *N. U. Crooker and G. L. Siscoe* 761
A Theory of Long Period Magnetic Pulsations, 3. Local Field Line Oscillations (Paper 3L0696) *Akira Hasegawa, King H. Tsui, and Altair S. Assis* 765
Magnetic Turbulence and Diffusion Processes in the Magnetopause Boundary Layer (Paper 3L0928) *R. Gendrin* 769